

A N A L Y S I S

OF THE

MEDICINAL WATERS

OF

TUNBRIDGE WELLS.

LONDON:

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ADVERTISEMENT.

THIS pamphlet originated in the following circumstance. By the direction of the Proprietor of the medicinal waters at Tunbridge Wells, a cover had been placed over one of the springs, with a view to defend it from any foreign matter, which either wantonness or accident might introduce. In consequence of this, a question

arose, whether or not the spring, thus covered, might be supposed to be, in any respect, altered in its qualities. In order to decide this question, the Author instituted a comparative Analysis of the two springs, and proved, by the most satisfactory experiments, that the only advantage, that can be derived to the spring by a cover, is cleanliness ; and, that the water is not alterable by its being either exposed, or covered, so long as such covering does not entirely exclude the external Air.

The Proprietor, in compliance with the general opinion, removed the cover, and the original object of the

present publication was thus superseded. The Author however, finding himself under some sort of engagement to satisfy the curiosity of friends, and reflecting, that no accurate Analysis of the Tunbridge waters had hitherto been given, now offers to the public these pages as the result of careful experiments; wishing at the same time not to appear to have been inattentive to this particular subject: since it is not unreasonable to suppose, that a scientific enquiry into the component parts of these springs may, in some measure, assist us with respect to the right application of them in medicine.

He likewise takes this opportunity of publicly acknowledging his obligation to the ingenious Mr. Babington, of Guy's hospital, by whose skill and dexterity in executing chemical experiments, he was greatly assisted in the Analysis.

INTRODUCTION.

IT may not be amiss, previous to our statement of the analysis of these waters, to mention, for the information of those who have not the opportunity of visiting them, or of consulting the authors that have written on the subject, that the springs from whence they flow are situated in a village about thirty-five miles southward of London, in a valley surrounded by a number of hills, which, though formerly wild and barren, are now, for the most part, cultivated, and many of them richly inhabited.

These hills seem to be chiefly composed of a crumbling, ferruginous sandstone; and, for several miles around, iron has been discovered in great abun-

dance. Upon the original discovery of the springs (which is supposed to have been about the year 1607) we are told they were numerous. At present, however, there are only two in use, which rise within a few yards of each other in the centre of the valley, and yield each about a gallon of water in a minute.

For many years the water was collected in two *open* stone basons, perforated at the bottom, and placed in such a manner over the springs, that, as the water rose, it flowed into the basons from below, whilst the waste water passed off by means of notches made in the edges of the basons for that purpose. But very lately *one* of these has been changed for a bason of marble, over which is fitted a marble dome, so as to inclose it completely, except at the marginal notch, or opening, which gives exit to the water nearly as usual. This alteration, inconsiderable as it may appear,

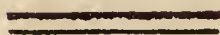
has given rise, it seems, to a difference of opinion; *some* conceiving that by thus excluding the contact of the atmosphere, the water was not likely to lose so much either of the elastic fluids it contained, or of its properties as a chalybeate; *others*, that by being deprived of the custom of dipping their vessels into the spring (as *formerly*) they have not the water so near the fountain-head, and consequently not so fresh and efficacious.

How far these opinions may be reconciled, will be seen by the analysis here submitted; which, it is hoped, will also determine two other material positions, much disputed by authors; namely, whether there be any essential difference between the waters of the *two* springs, as they originally stood; and what is the true nature of their *impregnation*.

For the more concise and perspicuous relation of the experiments which have been made on this subject, let the in-

clofed spring be expreffed by the letter A; the open, by B; and the *inclofed* one (after having been uncovered about twelve hours) by C: and let it be underftood, that by a *meafure* of any liquor employed, is meant a quantity exactly afcertained in a cylindrical glafs-jar, graduated and kept for that purpofe.

OF THE ANALYSIS.



IN the process of this analysis, the first thing attended to was the sensible properties of the waters. In this respect no difference whatever could be observed between A and B. The water of *both* was equally clear and tranquil; they had *both* a distinct chalybeate smell and taste, and were *both* found, by an accurate thermometer, to be at a temperature of 50°. There was also observable an equal ochry deposit on the channels leading from the respective basins, as well as on the sides and bottoms of the basins themselves. This similarity being noticed, the following experiments were made on A and B, nearly, though not exactly, in the order in which they are here related.

EXPERIMENT THE FIRST.

EQUAL measures of the water, taken immediately from the wells, were exposed in open glasses about ten hours, in a room at a temperature of 55° ; at the end of which time the internal surfaces of the glasses were universally studded with air-bubbles, and the water in both was covered with a purplish shining pellicle. The air-bubbles were smaller, but more numerous, in B than in A; and the pellicle was seemingly more copious.

EXPERIMENT THE SECOND.

EQUAL measures of an infusion of galls being added to equal measures of the waters, a beautiful purple-colour was produced, after a few seconds; in *both* so very similar in shade, that it was impossible to say which of the two was the deeper.

EXPERIMENT THE THIRD.

A SOLUTION of Pruffian lime, employed in the fame way, changed them *both* to a light blue, of no apparent difference.

EXPERIMENT THE FOURTH.

INFUSION of litmus was equally and almost instantly changed, by *both*, to a light red or garnet colour.

EXPERIMENT THE FIFTH.

WITH fyrup of violets no fenfible alteration could be perceived at firft; but, on leaving them to ftand fome time, the blue colour of the violet was altered to a green.

EXPERIMENT THE SIXTH.

By a solution of acid of sugar no visible effect was produced in *either*.

EXPERIMENT THE SEVENTH.

On the addition of a solution of muriated barytes, a cloudiness immediately took place, not however to a greater degree in *one* than in the *other*.

EXPERIMENT THE EIGHTH.

NITROUS solution of silver occasioned at once an evident precipitation. The precipitate was at first of a pearl-colour, but, on remaining exposed to the light for a few hours, it became of a muddy blue. In neither of these respects was there any distinction to be observed.

EXPERIMENT THE NINTH.

By a solution of soap in spirit of wine *both* the waters were rendered wheyish.

EXPERIMENT THE TENTH.

THE same appearance was effected by a solution of sugar of lead.

EXPERIMENT THE ELEVENTH.

By volatile tincture of sulphur they were immediately changed to a deep bottle-green.

EXPERIMENT THE TWELFTH.

LIME-WATER rendered *both* slightly turbid, and produced a light yellowish brown colour; as did also the mild alkaline solutions.

EXPERIMENT THE THIRTEENTH.

THERE was neither precipitation nor effervescence discernible in *either* from concentrated vitriolic acid, nor any visible effect from arsenic or corrosive sublimate.

EXPERIMENT THE FOURTEENTH.

ON trial of the waters, after exposure (experiment 1st) with the tincture of galls, Prussian lime, and infusion of litmus, the same changes took place as in experiments 2d, 3d, and 4th, though not in so great a degree; the shades of colour appearing now considerably weaker. These experiments having been made on A and B, were all (except the first) repeated on B and C, with precisely the same result. In no instance could the slightest variation be perceived.

EXPERIMENT THE FIFTEENTH.

Two great decanters, filled under the surface of B and C, and inverted into two basons, were set in this situation before an open fire, where they continued between three and four hours. Here it was observed, that as the water grew hot, there was extricated from it a quantity of air, which collected itself in the superior part of the decanters; and, in proportion as the air was separated, the water became turbid, and at last, when it had acquired nearly a boiling heat, it was found to be altogether ochry. While the decanters were hot, the air occupied a space of several cubic inches in each, but being cooled down to the temperature of the atmosphere, there did not appear to remain above two cubic inches in both.

EXPERIMENT THE SIXTEENTH.

A GALLON of the water of A, boiled for a few minutes in an open vessel, became ochry throughout, as in the last experiment. Being filtered, it was found incapable of producing any alteration in the infusion of litmus, or of shewing any effect whatever with the tincture of galls, or Prussian lime. The whole ochre collected by the filter proved, when dried, to be strongly *magnetic*.

EXPERIMENT THE SEVENTEENTH.

Two quarts of the above filtered water were evaporated down to four ounces, without yielding a further deposition of any kind, the liquor, even when cooled, remaining perfectly transparent. The nitrous solution of silver and muriated barytes both now produced a copious

precipitation, but still the acid of sugar seemed to have little or no effect.

EXPERIMENT THE EIGHTEENTH.

To ascertain the proportion of solid contents to a given quantity of the water of A, two gallons of it boiled and filtered, as in experiment the 16th, were carefully evaporated to dryness, and yielded exactly eight grains of residuary matter; the ochre collected by the filtre, when dried, weighed only two grains.

EXPERIMENT THE NINETEENTH.

THE residuary matter of the last experiment, digested for twelve hours in four ounces of alcohol, was found soluble in this menstruum, in the proportion of three grains and a half to four grains and a half. What the spirit left

undissolved being afterwards digested, for the same length of time, in two ounces of distilled water, there was left but one grain of insoluble matter, which was perfectly insipid to the taste, and insoluble in diluted marine acid.

EXPERIMENT THE TWENTIETH.

ON the evaporation of the alcohol of the preceding experiment, the residuum was found to be deliquescent, and of a bitter saline taste; it gave out abundance of white elastic pungent fumes on the application of vitriolic acid; produced an instant precipitation on a particle of it being dropped into the solution of nitrous silver; and, when dissolved in water, yielded, on the addition of a little vegetable alkali, a light white earthy precipitate, which, diluted vitriolic acid readily redissolved.

EXPERIMENT THE TWENTY-FIRST.

THE evaporation of the water (experiment 19th) afforded a very different result; when it was reduced to about two drachms, there appeared upon the surface a thin saline pellicle, which, from its difficult solubility and insipidity, and more especially from its affording a precipitate as well on the addition of acid of sugar as muriated barytes, proved to be *selenite*. This continued to separate from the liquor till the whole was evaporated to dryness, when it was found that, besides the selenite, there remained a small proportion of common salt, too small to be estimated by the balance, but perfectly distinct to the taste, and appearing in well defined cubes when a drop of the solution was placed under the microscope.

EXPERIMENT THE TWENTY-SECOND.

A SMALL matrafs, containing four ounces by measure, and having a glafs fyphon accurately fitted to it, was filled under the surface of the water of C, and, whilst perfectly full, the extremity of the fyphon was passed under a glafs jar, filled in the same manner under water, and inverted into a small bason. The vessels being thus connected, the water in the matrafs was afterwards made to boil, by means of a lamp, for about five minutes, when there was found collected in the jar half a cubic inch of air, the water having undergone the same change, as mentioned in experiments 15th and 16th. This air, upon being passed through lime water, was diminished two thirds in its bulk, and occasioned an instant precipitation of the lime; the remaining part of the air was found incapable of supporting flame,

but suffered a small diminution of bulk on mixture with nitrous air. In these respects the water of B, upon trial, appeared the same.

EXPERIMENT THE TWENTY-THIRD.

ON comparing the specific gravity of B with C, they were found to correspond exactly, and to exceed that of distilled water in the proportion of 713° to 712°.

HAVING thus finished the account of the experiments made on these waters, let us now see to what conclusions they will lead.

In the first place then it is proved, agreeable to the received opinion, (experiment 1st, 2d, 3d, 5th, 11th, 12th, 15th, and 16th), that they contain *iron*, and this in an ærated state, that is, held in solution by union with *aerial*

acid, (experiments 1st, 15th, 16th, and 22d); though it appears from a variety of circumstances, that the quantity contained is not very considerable. Only two grains of the calx of iron could be obtained from two gallons of the water, (experiment 18th), which corresponds not only with the purple colour produced by the tincture of galls, (experiment 2d), but also with the manner in which this colour took place; as likewise with the taste of the water, which, though distinctly chalybeate, is not by any means strongly so, when compared with many other waters of this kind. All vegetable astringents, as has been long known, change solutions of iron to a dark colour, and the galls, as the strongest of these, do this the most readily and perfectly. But it is not only for ascertaining the presence of this metal, that we employ this test; we may also form by it a pretty accurate judgment

with regard to proportion. When this is large, the colour changes immediately, and is always black; but when it is inconsiderable, it turns out, more or less, of a purple; and if the acid be in excess, as we suppose the ærial acid in these waters, some time will be required before the colour makes its appearance. To this may be added, the slight precipitation produced by lime water, or the alkaline solution (experiment 12th); and more especially the light blue colour, which appeared on the addition of Prussian lime (experiment 3d): a test so delicate with regard to iron, that one quarter of a grain may be detected by it in a gallon of water.—The colouring matter combined with lime in this test, or, as it is often prepared, with alkali, is what constitutes the Prussian blue of the shops, when united with calx of iron.

It appears equally clear that there is also contained in these waters a quantity

of *muriatic acid* (experiment 8th) partly combined with *magnesia* (experiment 20th), and partly with *fossil alkali* (experiment 21st): in other words, *muriated magnesia* and *common salt*; for we know that the presence of muriatic acid in solution is concealed with great difficulty, there being few bodies in nature which combine more readily, or more minutely, than this and calx of silver, while the properties of the compound which they form are so remarkable, that it is next to impossible to mistake them. One of the most characteristic of these, viz. the change of colour upon exposure to light, the precipitate (experiment 8th) was found to possess; which, when connected with the decomposition resulting from the application of the vitriolic acid to the residuum left by the alcohol (experiment 20th) puts the matter beyond all kind of doubt. Neither can there be any

uncertainty with regard to the nature of the basis to which the muriatic acid is here united; since there is no other earth, besides magnesia, which forms with this acid a bitter deliquescent salt, and is at the same time soluble in vitriolic acid; nor any other body which resembles common salt in the properties above-mentioned, except the digestive salt of Sylvius; which however, in the analysis of mineral waters, has seldom been met with.

If any one should wish to be satisfied of the degree of minuteness to which chymical investigation may be carried, he need not seek for a clearer illustration than that to which we have just referred. Let him take the smallest visible particle of any of the soluble compounds of muriatic acid, such as common salt, common ammoniac, digestive salt of Sylvius, or any other; and, putting it into a tumbler of distilled water,

let him add but a single drop of solution of nitrated silver, and he will presently be convinced how far chymical division goes beyond the power of any other means the art of man has ever yet devised.

The next thing our experiments teach us, is the presence of a quantity of *vitriolated lime* or *selenite*. This appears on the simple evaporation of the water (experiment 21st), and explains very satisfactorily the result of experiment the 7th; seeing it is the property of heavy earth, or barytes, as it is called, to unite with vitriolic acid, whenever it meets it, and to form therewith a very heavy and insoluble compound.

Should it be asked why the acid of sugar, as delicate a test of lime as barytes is of vitriolic acid, did not detect the lime of the selenite, in experiment the 6th and 17th; the answer is, that it was not allowed sufficient time to produce its effects. Had the lime been in

union with any other acid than the vi-
triolic, a precipitation would in all pro-
bability have taken place immediately;
but between this and the acid of fugar,
the attraction of lime is so nicely ba-
lanced, that we are obliged to wait
longer than in most other cases of de-
composition before the superiority of
the latter becomes apparent. The truth
of this opinion was confirmed by a sub-
sequent experiment.

WE come now to speak of the elastic
fluids or airs. These, as extricated from
the waters (experiment 22d), appeared
to be of three kinds.

First, *æerial acid*, or fixed air, that
which was absorbed by the lime water.

Secondly, *phlogisticated air*, or, as the
French call it, *mosette*, the residuum left

by the lime water, or rather that part of the residuum which the water could not absorb (experiments 15th and 22d); and which was found incapable of supporting flame, or of being diminished in bulk by mixture with nitrous air.

Thirdly, *common air*, or that part of the residuum which nitrous air did diminish.

When, for example, we find the infusion of litmus changed red (experiment 4th), we say it is because the ærial acid is in excess, or that the water contains more of it than the calx of iron can combine with. We say also that the ferruginous pellicle, observable on the surface of these waters, after exposure (experiment 1st), and the diminution of their effects in experiment 14th, must depend upon the separation of the ærial acid from its union with the calx of iron, in consequence

of the alteration of temperature, and the strong propensity of this acid to assume an elastic form.

But, however distinct these may appear upon examination, we must not be too hasty in inferring that they exist so in the composition of the water; on the contrary, we have reason to suspect that both the phlogisticated and common air were here produced from the decomposition of ærial acid: for it is found by experiment, that where this substance has been imbibed by water, and afterwards separated by the application of heat, it always leaves a residuum, on being agitated with lime-water, corresponding very exactly in its properties with that above referred to. Be that as it may, it is this volatile acid which beyond all dispute gives solubility to the calx of iron, with which these waters are impregnated; a circumstance which best accounts for many other im-

portant phenomena occurring in their chemical history. Hence certainly the reason why such waters cannot be carried in perfection, to a distance; and why it has been proposed, with a view to preserve their virtues, that a small quantity of elixir, or acid of vitriol, should be added to them at the time of bottling; which, however, though it render their chalybeate properties more permanent, occasions a material alteration in the nature of the compound, from which these properties arise. In the same manner we explain, why it was necessary that a certain time should elapse before the colour of syrup of violets was altered in experiment 5th, and why the boiling was so effectual in producing the ochry deposit (experiments 15th, 16th, and 22d). Had the iron, in these experiments, been combined with any other than a volatile menstruum, it certainly could not have

been either so readily or so completely separated.

Upon collecting then the different substances, the existence of which seems to be demonstrated by these experiments, and estimating their proportions as minutely as the nature of such an investigation will admit, we may state that a wine gallon of these waters contains,

				Cubic Inches.
Of ærial acid	-	-	-	10 $\frac{6}{10}$
Phlogisticated air	-	-	-	4
Common air	-	-	-	1 $\frac{4}{10}$
				<hr/>
				16
				<hr/>
Calx of iron	-	-	-	1 grain.
Common salt	-	-	-	$\frac{5}{10}$
Muriated magnesia	-	-	-	2 $\frac{25}{100}$
Selenite	-	-	-	1 $\frac{25}{100}$
				<hr/>
				5

But further; if the experiments be just upon which this analysis is founded, does it not follow that, whatever be the virtues of these waters, they are

equal in *both* the springs, and, that notwithstanding what some may think to the contrary, the alteration made in *one* of them, in the manner already mentioned, has had no effect whatever, either in giving to the water properties which it did not before possess, or in strengthening or diminishing those, for which it has so long been remarkable. We find this spring, both open and inclosed, compared with the other, under various circumstances; but no difference whatever could be discovered. Their sensible properties were the *same*; they produced the *same* changes on a great variety of the most delicate substances; were affected in the *same* way by heat and exposure; evolved the *same* kinds of air, and yielded the *same* kind of solid contents. In short, they were found alike in every point of view in which they could possibly be taken.

It would indeed be difficult to con-

ceive how this should be otherwise; for the ærial acid, which every body will acknowledge to be the principal agent here, is heavier than common air, and there is a free communication with the atmosphere immediately over the surface of the water: what then can prevent this acid from escaping? Must it not, in consequence of its weight, make its way to the outlet, or aperture, as the water does, and be continually diffused? There is no doubt it must; and were it not, that the water contained in the basin, being small in quantity, is undergoing a perpetual change, we have reason to believe, that in the superior part of it the effects of exposure would be sensible.

With regard to the manner in which these waters may be supposed to receive their impregnation; it is probable, that the spring from which they originate is at a considerable depth, within the

bowels of the earth, and that the iron which they contain is taken up in their passage to the surface. We suppose them, in the first instance, to be a common water, containing selenite, muriated magnesia, and common salt, in the small proportions just stated, together with a quantity of ærial acid, as yet in an uncombined state. After this we suppose them to pass through a stratum of iron-stone, with which (as already observed) this country abounds. In this stage, and not before, they become chalybeate; and from this time, till they reach the surface, the only substance they meet with, is sand, which being itself strongly impregnated with iron, is rather calculated to improve than impair them. That the source is deep, and not subject to the changes which are constantly going on in the superior strata of the earth, appears from hence, that these waters, though

covered with a sandy foil, are scarcely affected by rain, and are found in other parts of this county, with very little alteration in their properties.

THE END.

